Renewables Get New Steam

By DINESH C. SHARMA

At first glance, Kirugavalu may look like a typical village in southern Karnataka—narrow but tarred and semi-pukka roads, small shops selling tea and bananas, vast fields of rice and sugarcane, children playing with old tires in the streets, and a primary school. But a closer look reveals something unusual—a shop selling fluorescent bulbs, tube lights, fancy switches and electrical wires. The village bazaar remains open well after sunset without kerosene lanterns and candles. Roadside kiosks and homes light up as soon as it is dark. The village is dotted with rice and oil mills that work all through the day without any interruption in power supply. The village was "electrified" several years ago, but the changes described here are recent. Electrification earlier meant supply of power to a few homes and farms for four to five hours a day. The voltage was so low that one needed to light a lantern, in addition to an electric bulb, even to do household chores.

The transformation at Kirugavalu, about 40 kilometers off the Bangalore-Mysore highway, is not a result of any government program or efforts by any voluntary group. It is the initiative of an innovative private firm that has set up a power plant in the village, using agricultural waste such as sugarcane refuse and coconut fronds that are plentiful in the area. Villagers sell such waste to the plant and get access to quality power at commercial rates. The waste that was burned in open fields has now become a source of income and jobs. The power unit set up by Malavalli Power Plant Private Limited (MPPL) supplies electricity to 48 villages inhabited by 120,000 people in Mandya district. The power plant is not a demonstration unit: its capacity is 4.5 megawatts and is among the largest biomass-based power installations in India.

"We have established a supply chain to procure agricultural waste from villages in a radius of 10 kilometers and transport it to the plant. This is very essential to keep the plant generating power year-round, without

Images courtesy U.S. Department of Energy/National Renewable Energy Laboratory. www.nrel.gov

JIM WELCH/Remote Power

Left: Solar panels bring electricity to a village home in West Bengal. With an average of 250 clear, sunny days a year, such systems have proven cost-effective in India.

Below: Solar panels and a wind turbine provide power to a home in Colorado.

Innovative projects, many privately run, signal the growing importance of renewable resources in the Indian power mix. These alternatives can help achieve the goal of "power for all" in a country where 56 percent of rural residents lack adequate power.

Photograph by WARREN GRETZ

any disruption in the supply of fuel," says Purushottam Nayak, the plant manager. Nearly 400 people are engaged in this exercise, while the unit has provided direct employment to 60 villagers. The plant needs about 170 tons of waste every day. The waste is chopped up and conveyed to the boiler for combustion. The heat that is generated makes steam, which then drives the turbine to produce electricity, explained M.A. Sharief, an engineer at the power station.

The power is then fed into the grid under a power purchase agreement the company has signed with the state-run transmission firm Chamundeswari Electricity Supply Company. MPPL also manages all transmission lines for the government utility and collects bills on its behalf. If the grid fails for some reason, the plant can switch to "island mode," continuing to operate and supply electricity to 48 villages. So, the chances of a blackout in these villages are remote.

The Kirugavalu plant is an example of how renewables—traditionally dubbed non-conventional or alternative sources of energy—can generate and supply commercial, grid-connected power. It signals the growing importance of renewable technologies in the Indian power mix. The country has a total installed capacity of about 126,000 megawatts, of which 66 percent comes from thermal power plants based on coal, gas and oil. Nuclear power accounts for 3.1 percent and the share of grid-connected power from renewable sources is about 6 percent. It is significant that renewable sources have overtaken nuclear power generation and are growing steadily. The overall renewable energy potential in India is pegged at 122,000 megawatts by 2032, as against the present 8,800 megawatts, according to the Ministry of Non-Conventional Energy Sources.

India began promoting alternative sources of energy more than two decades ago. In 1981, a commission for additional sources of energy was set up and after a series of policy measures and administrative changes, a full-fledged ministry devoted to alternative energy sources was born in 1992. In this period, several research projects and demonstration plants using alternative sources of energy were set up across the country, but renewables were never integrated into overall energy planning. Their economic viability could not be established as they were showered with direct and indirect subsidies. In addition, budgetary support for renewable sources has been low compared to thermal and nuclear energy. As a result, thousands of biogas plants, solar lighting systems and biomass gasifiers set up in villages became dysfunctional and eventually earned a bad name for the sector.

The scenario changed in the mid-1990s with economic liberalization, when subsidy-based promotion was replaced with a market-oriented, commercial approach. Instead of direct financial subsidies, a slew of indirect fiscal incentives such as low-interest rates for manufacturers were introduced. A separate financing agency, the Indian Renewable Energy Development Agency, was set up to finance commercially viable windpower and other projects. Meanwhile, the new ministry's policies and programs were restructured based on end-use such as rural energy, urban and industrial energy; and power generation. Earlier the focus was to push biogas, solar and wind technologies without reference to their end-use viability. The shift moved the share of non-conventional sources way ahead of the nuclear sector.

"Renewables have to be brought into the mainstream," says K. Krishan, chairman of Malavalli Power Plant Private Limited. "For too long, they have been on the developmental platform. So far, research laboratories, non-governmental organizations and development funding institutions like the World Bank have been involved in this sector. We need to mainstream renewable energy. The message should be clear—it is serious business."

In the popular perception, solar energy has been synonymous with alternative energy. People think it is cheap, abundantly available in poor countries; yet it is not widely used. The reason is not hard to find. It is not technically and economically feasible to construct large-scale solar power plants and connect them to the grid at the present stage of scientific knowledge.

When sunlight strikes a photovoltaic cell, chemical reactions release electrons, generating small electrical currents. Since these currents are direct, the type used in batteries, they must pass through an inverter where they are converted into alternating current, the type that comes over power lines. All this makes solar power costly and less efficient. But solar energy can be used profitably for specific tasks such as water heating, air heating, drying of agricultural produce, cooking, desalination, refrigeration and water pumping. Many of these systems are commercially available and widely used in India. In a country with an average of 250 clear, sunny days a year, such systems have proven viable and cost-effective.

The efficiency of conversion of sunlight into electrical energy is up to 15 percent at


Courtesy Applied Power Corporation


WARREN GRETZ

USAID Project Cow Manure and Microturbines Mean Power for Villages

The mooing of cows and the humming of a small turbine: Together, these sounds mean electricity for villagers in Purulia, West Bengal, and perhaps in other parts of rural India.

The first example of the use of a microturbine to generate electricity in India began in July by adding 25 kilowatts to the local grid. Tiny turbines may be a new idea but the source of energy to run them is as old as India. It's biogas: In this case, the methane gas emitted from the manure that is emitted from the cows at the Mohan Dairy in Purulia, 300 kilometers west of Calcutta.

This $265,000 model electricity plant was primarily funded by the West Bengal Renewable Energy Development Agency, with support from USAID, and expertise from the California-based Capstone Turbine Corporation. The company supplies the microturbines that capture methane and generate electricity at landfill sites in the United States, Europe and East Asia. USAID conceived the project, brought the partners together, and provided $73,000 to train people to maintain the equipment. Capstone helped modify the American gas conditioning system for local conditions.

The ultimate benefit of microturbines will be realized when they are able to operate in a stand-alone mode and provide electricity to village dwellers. In rural India only 20 percent of households have access to electricity. Decentralized energy projects such as biogas-based power generation are options that can help such areas. —L.K.L.

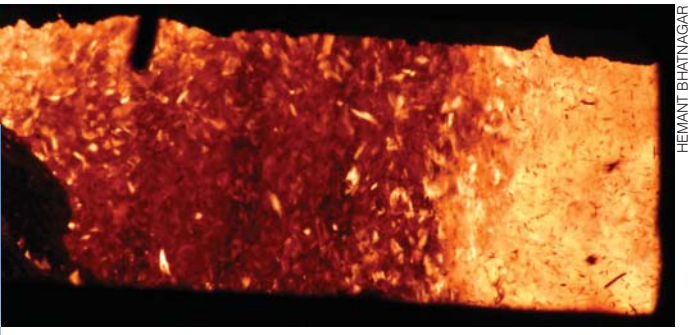
the current level of knowledge of photosensitive materials and technologies. New advances in nanotechnology and molecular biology hold the promise of a breakthrough in the future. "Powerful new methods of nanoscale fabrication, characterization and simulation—using tools that were not available as little as five years ago—create new opportunities for understanding and manipulating the molecular and electronic pathways of solar energy conversion," notes a U.S. Department of Energy report from September 2005, *Basic Research Needs for Solar Energy Utilization*. "Additional optimism arises from impressive strides in genetic sequencing, protein production and structural biology that will soon bring the secrets of photosynthesis and natural bio-catalysis into sharp focus. Understanding these highly effective natural processes in detail will allow us to modify and extend them to molecular reactions that directly produce sunlight-derived fuels that fit seamlessly into our existing energy networks."

In wind energy generation, India has made rapid strides. Wind accounts for more than half of the 8,000 megawatts produced through renewable sources. This makes India the fourth largest wind power producer in the world, after Germany, Spain and the United States. However, wind power depends on the weather. That's why installed capacities may look large but the number of electricity units generated may be low. As it is capital intensive and location specific, wind is not considered suitable for meeting power needs in rural areas.

While solar and wind may face technical and financial obstacles in producing grid-connected power, biomass is emerging as a viable source of power for rural electrification in India. Biomass such as firewood, agricultural residue, bagasse, crop stalks, rice husks, coconut shells, animal dung and waste from agro-based industries can be used to produce power. Direct burning of such waste is inefficient and leads to pollution. When combusted in a gasifier at low oxygen and high temperature, biomass can be converted into a gaseous fuel known as producer gas. This gas has a lower calorific value compared to natural gas or liquefied petroleum gas, but can be burned with high efficiency and without emitting smoke.

India produces an estimated 600 million tons of agricultural residue every year. If all of this waste is gasified, it can produce 79,000 megawatts of power—about 63 percent of the total power available in the country from all sources, according to Anil K. Rajvanshi. He earned a doctorate in solar energy from the University of Florida and runs the non-profit Nimbkar Agriculture Research Institute in Phaltan, Maharashtra. "It is feasible to set up a biomass-based power plant of 10 to 20 megawatts capacity in every *taluka* (a block of about 100 villages). This can meet energy needs of villages and employ thousands of people," says Rajvanshi. He suggests a separate utility company in each *taluka* to produce and supply power. This utility can lease existing transmission and distribution networks of state electricity boards, instead of developing its own. Also, micro-utilities covering a few villages could be connected to the *taluka* level utility. Local electric cooperatives could function like cable television operators in rural areas. Krishan estimates that India can produce 30,000 megawatts of power from biomass. As a first step, he intends putting up showcase 100-megawatt projects over the next three to four years. The plant at Kirugavalu is the first.

However, like wind and solar, power availability from biomass is dependent on consistent access to the quantity and quality required to run a plant. Due to harvesting cycles this may not be possible throughout the year. Since availability of power from each of the major renewable sources—solar, wind and biomass—is dependent on several factors, scientists are exploring possibilities of using them in combination. The U.S based company General Electric (GE) is working on an integrated hybrid technology model, which combines various forms of renewable energy and provides customized power solutions based on the availability of



HEMANT BHATNAGAR

Far left: A photovoltaic system being installed at a wind farm near Coimbatore

Left and above: The powdery residue of sugarcane is burned to generate electricity. Such biomass projects are emerging as a viable source of power for rural electrification in India.

You Can Save Energy

Housing

- In hot climates, plant shade trees to cool roofs, walls and windows. Close blinds or shades in south- and west-facing windows. In cooler climates, allow sun to reach south-facing windows.
- Seal air leaks around doors and windows.
- Use ceiling fans in summer and winter. By reversing the direction of the blades, warm air is pushed down, helping to keep rooms warm in winter.
- Lower house thermostats in winter. Just a one-degree-Celsius reduction can reduce heating costs by about 4 percent. Regularly clean or replace filters in air conditioners and furnaces.
- Switch to fluorescent lightbulbs, which last six to 10 times longer than incandescent bulbs; add more natural lighting with additional windows.
- Put reflective tiles on roofs and adequate insulation in attics.
- Use low-flow aerating showerheads. Lower the thermostat on the water heater to 49 degrees Celsius.

Consumer Products

- Buy major appliances labeled with the highest efficiency rating. The electricity savings from today's refrigerator model with a high rating compared to a 1990 model would save enough electricity to light a home for almost five months.
- Use renewable products: bamboo or linoleum in flooring, for example.
- Wash only full loads of clothes. Wash clothes in cooler water, using cold-water detergents. Clean the lint filter in dryers after loads to improve energy efficiency.
- Turn off your computer, monitor and other electrical devices when not in use.

Transportation

- Avoid erratic driving. Quick stops and starts can decrease gasoline mileage by 33 percent on the highway and by 5 percent in the city.
- Maintain your car. Clean air filters can improve gasoline mileage by as much as 10 percent. Properly inflated and aligned tires will increase mileage by as much as 3 percent. But using the wrong grade of oil can reduce mileage by 1 to 2 percent.
- Observe the speed limit. In general, every 8.05 kilometers per hour over 96.6 kilometers per hour increases the cost of gas by 2.3 to 8.28 rupees per liter at mid-2006 gas prices.
- Avoid carrying extra weight. Every 45 kilograms decreases fuel efficiency by 2 percent.
- Consider buying a hybrid car. The increased gasoline mileage relative to gasoline-only cars can reduce fuel use by 50 percent or more. □

Sources: Smithsonian Institution, U.S. Department of Energy, American Society of Interior Designers, Alliance to Save Energy

KATRIN SCHOLZ-BARTH

A 2,045 square meter garden atop the 12-story Chicago City Hall demonstrates that green roofs help to reduce air temperature in urban areas.

local fuel resources. "You may not have all the resources available in all the villages. So, depending on fuel availability in a particular area, we can combine different sources of power," says Kannan Tinnium, manager of electric power technologies at GE's John F. Welch Technology Centre, near Bangalore.

Developing a hybrid system poses technical challenges ranging from cost to control. As Tinnium puts it: "First, we need to select the right combination of technologies that will give the lowest cost power. Second, we need to address the potential for "intermittent power" caused by variable fuel quality and availability. Third, we want the power to be available in grid-connected mode as well as island mode, with smooth transitions between the two. For this, we need energy storage technologies to maintain the load during transition. And lastly, we need to have energy management and control systems that can handle different kinds of loads such as irrigation pumps and other motors in rural areas that are energy intensive and require large amounts of power at startup."

GE began addressing the challenges of introducing intermittent power sources into the grid with a series of acquisitions—Enron's wind business in 2001, Austrian gas engine manufacturer Jenbacher in 2003 and AstroPower, a maker of solar electric power equipment, in 2004. GE's technology fuel base now encompasses hydro, wind, solar, alternative fuels like biogas, crop residue, municipal solid waste, coal mine methane and industrial waste gases, besides traditional fuels like natural gas, coal and nuclear.

The company is also participating in a new initiative to promote renewable technologies in India—launched in April 2006 by the U.S. Agency for International Development. USAID plans to contribute $600,000 to this program, while GE and its technology centers will invest up to $2.7 million in direct and indirect funding. "The challenge in promoting renewable technologies is not in the science or engineering part of it, but in their implementation and integration in overall energy policies," says Glenn Whaley, director of the Office of Environment, Energy and Enterprise at USAID in New Delhi.

At present, 56 percent of India's 700 million rural residents lack an adequate or reliable power supply. More than 100,000 villages have no power. The government has set an ambitious target of "power for all by 2009." Renewable sources of energy—either connected to a grid or in stand-alone mode—can help achieve this goal. A major challenge, however, is to make renewables competitive with fossil fuels and nuclear plants, because consumers are not willing to pay a higher price for electricity produced from biomass, wind or sunlight, however green it may be. □

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